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many of the pollutants in the high CO₂ gas produced by that process—whereas these pollutants are largely removed in the present invention. 4) From a cost perspective, the present invention utilizes essentially the same compression equipment is but the ASU of oxyfueled combustion requires more expensive equipment than the ASU since the cryogenic temperatures required for oxygen separation also requires alloy materials such as austenitic stainless steel in heat exchangers and distillation towers. In contrast, relatively small amounts of alloy are preferred in the present invention downstream of the gas expander for heat exchange with the incoming flue gas and absorbent.

Compared to flue gas treatment by MEA. 1) Amine treatment requires separate SO₂ removal since MEA reacts so strongly with SO₂ that the resulting salt is not broken by thermal regeneration as is the case for CO₂. 2) The regeneration of CO₂ from MEA requires nearly half of the power plant steam and thus greatly reduces the power produced. In the present embodiment of the invention, the net power requirement is substantially less than for the MEA process. 3) From a cost perspective, the absorption equipment of the present invention is smaller because of a higher operating pressure than for MEA, however, the compression and expansion equipment is more expensive than equipment for the MEA process. Thus the processes are probably close in cost.

Simulations of both propylene carbonate and methanol absorbents were performed using the process simulator AspenPlus™ to determine the power requirements relative to MEA. The table below summarizes the results compared to the NETL Case 12 MEA power requirements. As shown, the present invention has a significantly lower power requirement than MEA. Intrinsically, a power requirement advantage also exists for the present invention over oxyfueled combustion. The gas compression power will be slightly higher for the present invention, but the gas expander of the present invention generates sufficient power to guarantee the benefit of the present invention compared to oxyfueled combustion.

Power Consumption Compression-PC Absorption	NETL Case 12 kW MEA	
ID Fans	10,746	ID Fans 10,120
PC Absorption Auxiliaries	4,180	Econamine Auxiliaries 21,320
HT-6120	-2,802	
Return pump	4,982	
Misc pumps & regen	2,000	
TE-6160	-63,749	
CO ₂ Compression	62,004	CO ₂ Compression 46,900
Air Compression	193,533	Lost Steam Power 206,000
Auxiliary Power Requirement	206,714	284,340

While various preferred embodiments of the invention are shown and described, it is to be distinctly understood that this invention is not limited thereto but may be variously embodied to practice within the scope of the following claims. From

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the foregoing description, it will be apparent that various changes may be made without departing from the spirit and scope of the invention as defined by the following claims.

What is claimed is:

1. A method for removing a preselected substance from a flue gas stream comprising:

cooling the flue gas stream by direct contact with a cool liquid to remove water from the flue gas stream;

compressing the flue gas stream to approximately 120 psia to remove additional water;

dehydrating the compressed flue gas stream with either a first absorbent or a first adsorbent;

cooling the compressed, dehydrated flue gas stream by indirect heat exchange with cold expanded flue gas components;

contacting the compressed, dehydrated flue gas stream with a second absorbent or a second adsorbent to physically absorb or adsorb the preselected substance;

regenerating the second absorbent or the second adsorbent, thereby releasing the preselected substance from the second absorbent or the second adsorbent into a separate stream; and

expanding the compressed, dehydrated, treated flue gas stream through a gas expander, thus producing electric power, and cooling the expanded stream which is reheated by indirect heat exchange with the compressed, dehydrated flue gas stream.

2. The method of claim 1 wherein at least one of said preselected substances contains a material selected from the group consisting of CO₂, SO₂, NO₂, HCL, H₂SO₄, SO₃, Hg, As, Se.

3. The method of claim 1 wherein heat exchange is performed between cooling water and the cool liquid in order to cool and condense water from the flue gas stream.

4. The method of claim 1 wherein contact between the flue gas stream and the cool liquid is performed in a quench tower, a spray tower, or a venturi scrubber.

5. The method of claim 1 wherein the compressing the flue gas stream comprises using a multistage compressor with intercoolers and an aftercooler to condense additional water from the compressed flue gas stream.

6. The method of claim 1 wherein the first adsorbent is triethylene glycol, the first absorbent is a small pore molecular sieve, and wherein the second absorbent is at least one of the following: propylene carbonate, methanol, a mixture of polyethyleneglycol dimethyl ethers, and normal methyl pyrrolidone (NMP), and wherein the second adsorbent is at least one of the following: metal organic frameworks, CO₂ selective natural zeolites, and CO₂ selective man-made microporous materials.

7. The method of claim 1 wherein the compressing the flue gas stream comprises using an axial flow compressor and an aftercooler to condense water from the compressed flue gas stream.

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